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ABSTRACT

Data on 36 autistic, 30 mentally retarded (MR), and 22 normal children (23-65 months old) was collected to develop a method of objective behavioral assessment for diagnosing autism and documenting symptom changes over time. Ss were observed and rated on the Behavior Observation Scale, an instrument which contains 67 objectively defined behaviors in the areas of general behaviors, language, response to stimuli, attending response, response to being held, inappropriate response to pain, and motility disturbance to stimuli. Factor analyses were performed for each diagnostic group. When the individual groups were examined, the autistic group could best be characterized by behaviors reflecting inappropriate interaction with people and objects; the MR group could best be characterized by solitary behaviors; and the normal group behavior could best be characterized by appropriate interactions with people and objects. (Operational definitions and procedures are detailed, and factor analyses of the preliminary data on 89 children are reported.) (SBH)

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The Behavior Observation Scale for Autism (BOS): Factor Analysis of Behaviors[1]

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Abstract

Data from a research project aimed at developing an objective assessment tool for establishing the diagnosis of autism are reported. The goals of the Behavior Observation Scale (BOS) are to differentiate among autistic, normal and mentally retarded children (ages 30-60 months) along objective symptom axes. Operational definitions and procedures are described in detail and factor analyses of the preliminary data on 89 children reported. Finally, a theoretical model for establishing objective diagnostic criteria is discussed.

The Behavior Observation Scale for Autism (BOS): Factor Analysis of Behavior [1]

In spite of the vast literature that has appeared since Kanner (1943) first introduced the term autism into psychiatric nomenclature over thirty years ago, there is as yet no objective method for quantifying behaviors considered to be autistic. Clinical descriptions of the syndrome are rich but provide no objective definitions of the behaviors they describe. Attempts to quantify the diagnosis by the use of various checklists and rating scales have not received widespread use because they fail to define behaviors objectively, generally rely on parental report, do not observe the children directly and have a priori definitions of autism which they attempt to confirm. Reports of observations of behaviors in structured settings have been aimed at quantifying autistic behaviors. However, these studies have generally focused on one or two behaviors and fail to describe the syndrome as a whole.

In spite of the fact that there is no method currently available to objectively establish the diagnosis of autism that has been agreed upon by all professionals, a consensus has emerged over the past decade that autism is best viewed as a syndrome defined by the presence of clusters of behaviors. For the purposes of our discussion, we use the definition of the Professional Advisory Board of the National Society for Autistic Children. According to this definition, autism is a behaviorally based syndrome or disorder which appears prior to 30 months of age and is manifested by typical disturbances in each of the following four areas: 1) developmental rates or sequences; 2) responses to sensory stimuli; 3) speech, language and cognitive capacities, and 4) capacities to relate to people, objects and events (Ritvo & Freeman, 1977).

Using this definition, we have designed a method of objective behavioral assessment for diagnosing autism and for documenting symptom changes over time. As is evident from the above definition, the syndrome of autism does not represent an all or none phenomenon. Rather, the syndrome is comprised of a heterogeneous set of behavioral symptoms that change over time. Our proposed method is comprehensive, objective, and quantitative. It is designed to separate and describe subgroups of autistic children by clinical parameters, and to discriminate between autistic children and children with other syndromes such as mental retardation, central language processing deficits, and specific sensory deficits. Furthermore, when constructing the scale, it was felt that various behaviors observed in the repertoire of autistic children might be unique to the syndrome while others are due to maturation (e.g., chronological age) or generally delayed development (e.g., level of cognitive function.

There were two reasons why these possibilities were considered when constructing a scale to assess the diagnosis and prognosis of autism. First, it has been well documented that most autistic children are mentally retarded (Lockyer and Rutter, 1970), and thus that autism and mental retardation can be expected to overlap and occur in the same patient. Second, it has been reported that autistic children with testable IQ's above 70 exhibit different behavioral symptoms and have different clinical courses than those with testable IQ's below 70 (Bartak and Rutter, 1976). Thus, our scale was designed to compare behaviors of autistic children with behaviors of normal and mentally retarded children. Care was taken to ensure that all the behaviors which were coded were: a) identified independently of any theoretical model or bias; b) objectively defined; c) reliably scorable; d) numeric, and thus suitable

Table 1

Chronological Age Distribution of Subjects

Age (Months)	Autistic	MR	Normal	Total
23	1	0	0	1
24-29	0	1	0	1
30-35	1	2	6	9
36-41	11	2	3	16
42-47	4	5	3	12
48-53	6	6	3	15
54-59	2	3	2	7
60-65	3	1	3	7
65	8	10	3	21
Total	36	30	23	89

Mental Age Obtained in Merrill Palmer Pre-School Performance Test

Age (Months)	Autistic	MR	Normal	Total
23	11	9	0	20
24-29	8	7	0	15
30-35	7	4	1	12
36-41	3	1	1	5
42-47	1	3	2	6
48-53	2	1	2	5
54-59	3	2	3	8
60-65	0	2	1	3
65	1	1	12	14
Total	36	30	22[1]	88

Distribution of IQ Obtained on Merrill Palmer Preschool Performance Test

IQ	Autistic	MR	Normal	Total
30	5	4	0	9
31-40	1	3	0	6
41-50	5	5	0	10
51-60	6	4	0	10
61-70	5	7	0	12
71-80	5	5	0	10
81-90	2	1	0	3
91-100	1	1	0	2
101-110	2	0	3	5
111-120	2	0	2	4
121-130	0	0	6	6
131-140	0	0	4	4
141-150	0	0	3	3
151-160	0	0	3	3
160	0	0	1	1
Total	36	30	22[1]	88

[1] MA and IQ not available on one subject

for statistical analysis; and e) applicable to normal children and children with developmental disabilities and specific syndromes. Finally, the scale was designed so that serial retests could be used to show how symptoms change over time.

METHODS

Subjects

Subjects for this research report included: 1) 36 children who meet the NSAC diagnostic criteria for the syndrome of autism; 2) 23 normal children and 3) 30 children with a diagnosis of mental retardation matched to the autistic group on the basis of mental age (as obtained on the Merrill-Palmer Preschool Performance Test).

Each child in the project was examined by two Board Certified child psychiatrists who determined the child's diagnosis. Developmental histories were taken and language and cognitive tests and medical examinations were given.

Table 1 shows the frequency distribution of chronological ages and Table 2 shows the distribtuion of mental ages and IQ obtained on the Merrill-Palmer Preschool Performance Test for the three groups. Table 2 shows that the autistic and mentally retarded groups were matched very closely on all parameters while the normal group was matched to the autistic group and the mentally retarded group on chronological age, but not on mental age and IQ.

Procedures

The Behavior Observation Scale (BOS) contains 67 objectively defined behaviors as listed in Table 3. Each child was observed through a one-way mirror in a playroom setting. The playroom contained age appropriate toys, a child's table and chair, two toy boxes, and one adult chair.

Each child was brought into the room by the examiner who told the child "to do anything he/she wants". If the child was crying, observations did not begin until the child was quiet. Once the child quieted, the examiner was seated in the corner and the observations begun.

Each observation consisted of recording the occurrence of the 67 behaviors defined on the BOS in nine, three-minute intervals. Each behavior was scored as follows: A score of "0" meant that the behavior did not occur in the three-minute interval, a score of "1" meant the behavior occurred once, a score of "2" meant it occurred twice, and a score of "3" mean the child engaged in the behavior more or less continuously throughout the entire three minute period. In addition, responses to standardized stimuli (e.g., spinning top, burglar alarm, intermittent flashing light, flashlight, a texture ball, a tuning fork, and the examiner) were recorded during the first ten seconds of seven of the nine intervals. Each session began and ended with a three-minute baseline observation period. During the procedure the examiner in the playroom presented the various stimuli without comment. During one of the three minute intervals the examiner actively interacted with the child by attempting to engage in ball play. At all other times, the examiner was passive, sat in a corner and did not respond if the child initiated contact.

Initial data were obtained by observing each child on three occasions, approximately one week apart. All behaviors were counted by two observers (the examiner in the room and another viewing via a one-way mirror) and exact-agreement interobserver reliability obtained. The procedure seems practical and high interobserver reliability ($r > .84$ on all but 12 behaviors) has been obtained.

General Behaviors (Each item scored 0-3):

Repeats Sounds (Attends to self-induced sounds)
Ear Banging
Tooth Grinding
Regards Hands
Staring
Visual Detail Scrutiny
Rubbing Surfaces
Mouths Objects
Repetitive Banging
Mouths Hands
Sniffs Objects
Sniffs Hands
Spins Top
Hand-flapping
Finger-flicking
Gesticulation/Grimacing
Whirling
Toe Walking
Darting/Lunging
Posturing
Body Rocking
Repetitive Jumping
Head Banging
Finger Wiggling
Nuccal Hyperextension

Insists on Being Held
Eye Contact
Attends to One Part of Adult
Social Smile
Uses Others as Extension of Self
Infantile Clinging
Ignores Examiner
Toys Used Functionally
Inspection of Objects
Manipulation of Objects
Purposeful Toy Play
Constructive Toy Play
Inappropriate Contact Attempt
Remains Preoccupied
Orders and Arranges Objects
Ritualistic Use of Objects
Uses Object to Generate Stimuli
Ignores Objects
Undifferentiated Holding of Objec
Lets Object Passively Fall From H
Spins Ojbect
Uses Part of Body To Generate Sti
Turns Flashlight On/Off
Turns Gong On/Off

Language (Each item scored 0 or 1):

Mute
Babbles
Cries
Communicative Speech

Immediate Echolalia
Delayed Echolalia
Negative Echolalia

Response to Stimuli (Each item scored 0 or 1):

Delayed
Staring at Stimulus
Anticipatory Response to Gesture
Response to Command for Eye Contact

Attending Response (One item, scored 0-6):

None
Minimal
Mild
Moderate
Severe
Very Severe
Panic

Response to Being Held (One item, scored 0-2):

Resists
Tolerates
Accepts

Response to Ball Play (One item, scored 0-3

Ignores
Minimal
Active
Deviant

Inappropriate Response to Pain (Scored 0-1):

Motility Disturbance to Stimuli (Scored 0-1):

Table 4

Definition of Factors Used in Analyses

FACTOR 1: Labeled Autism

Remains Preoccupied
Stares at Stimulus
Ignores Examiner
Attending Response
Visual Detail Scrutiny
Resists Being Held
Staring
Rubbing Surfaces
Ball Play
Undifferentiated Holding of Objects

FACTOR 2: Labeled Normal

Constructive Use of Toys
Toys Used Functionally
Social Smile
Communicative Speech
Purposeful Use of Toys
Eye Contact
Rubbing Surfaces (-)
Ignores Examiner (-)
Stares at Stimulus (-)

FACTOR 3: Labeled MR

Regards Hands
Tooth Grinding
Toe Walking
Whirling
Mouths Hands
Ignores Objects
Uses Body to Generate Stimuli

FACTOR 4: Labeled People (young normal)

Clinging
Insists on Being Held
Attends to One part of Adult
Uses Others as Extension of Self
Inappropriate Contact Attempts

FACTOR 5: Labeled Objects (young normal)

Spins Top
Ritualistic Use of Objects
Orders and Arranges Objects
Uses Object to Generate Stimuli
Finger Flicking

Table 4 (cont)

FACTOR 6: Labeled Inappropriate Objects

Inspection of Toys
Manipulation of Toys
Spins Top Inappropriately
Deviant Ball Play

FACTOR 7: Labeled Negative Use of Objects

Mouthing Objects
Banging Objects
Uses Object to Generate Stimuli
Lets Object Fall from Hand
Sniffs Object

FACTOR 8: Babbles

Data Analysis

Composite scores for each behavior were computed from the recorded ratings across observers, observation intervals, and sessions. Thus, each of the 89 children received scores which were the averages of 54 observations for each of the 67 behaviors. Complete data were available on 83 children, 30 autistic, 30 mentally retarded and 23 normal. Several behaviors having to do with specific use of the toys and crying were not recorded during the initial phases of the study and were thus eliminated. For statistical analysis, delayed and negative echolalia occurred so infrequently that they were combined with echolalia. In addition, the measurement of communicative speech was rescaled by dividing by chronological age. This modification was employed because the use of speech is highly dependent on maturation. Thus, 59 variables were included in the subsequent analyses.

Principal component factor analyses (Dixon and Brown, 1977; Program BMDP4M) were used as an exploratory technique in the preliminary analysis of the data. This technique permits the determination of which behaviors appear to characterize behavioral differences among the three groups, and to what extent children can be correctly classified into diagnostic groups by using these variables.

RESULTS

Factor analyses were performed for each diagnostic group. The results indicated that the majority of behaviors comprising each factor would be summarized by one of four categories: Interaction with People, Interaction with Objects, Solitary Behaviors and Response to Stimuli. When the individual groups were examined, the autistic group could best be characterized by behaviors reflecting inappropriate interaction with people and objects

(i.e., Remains Preoccupied with Objects, Visual Detail Scrutiny, Rubbing Surfaces, Undifferentiated Holding of Objects, Ignores Examiner, Resists Being Held and Deviant Ball Play) while the mentally retarded group could best be characterized by solitary behaviors (i.e., Sniffs Hands, Regards Hands, Nuccal Hyperextension, Toe Walking, Whirling, Mouths Hands, Finger Flicking and Ignores Objects). On the other hand, the normal group's behavior could best be characterized by appropriate interactions with people and objects (i.e., Rubbing Surfaces (-), Toys Used Functionally, Turns Gong On and Off, Uses Object to Generate Stimuli, Spins Top, Ignores Examiner (-), Communicative Speech, Social Smile, Eye Contact and Mute (-).

In spite of the fact that each group appeared to be best categorized by different sets of behaviors, the data indicated overlap among the groups. Therefore, the behaviors which made up the general factors were grouped and labeled as shown in Table 4. It is important to remember that the labels chosen for the factors are somewhat arbitrary and tentative. As a consequence, interpretations of the data should only be made in light of the definitions given. As a result of our previously reported findings that some of the individually coded behaviors varied as a function of chronological and/or mental age (Freeman, Ritvo, Guthrie, Schroth and Ball, 1978), we hypothesized that at least some of the behaviors within each factor or the factors themselves could be expected to depend on chronological and/or mental age. The sample size is not large enough to permit discriminant analyses of factors as a function of chronological or mental age in the groups. However, correlation coefficients between the labeled factors (i.e., those defined in Table 4) and mental age and chronological age were computed and the significant ones and their p values are summarized in Table 5A and 5B. In general, these data support the hypothesis that at least some of the labeled factors represent developmental phenomena.

Table 5

Significant Correlation Coefficients Between Identified Factors and Chronological Age (CA) and Mental Age (MA) For Each Diagnostic Group

A. Factors Correlated with CA

Autistic Group:	MA:	r = .439, p = .013
Retarded Group:	MA:	r = .631, p = .0006
	Objects:	r = .443, p = .023
	Negative Use of Objects:	r = .403, p = .041
Normal Group:	MA:	r = .876, p = .0001
	Autism:	r = -.465, p = .025
	People:	r = -.458, p = .028
	Normal:	r = .459, p = .028

B. Factors Correlated with MA for Each Group

Autistic Group:	CA:	r = .439, p = .013
	MR:	r = -.515, p = .004
Retarded Group:	CA:	r = .631, p = .0006
	MR:	r = -.552, p = .003
	Objects:	r = .414, p = .036
	Normal:	r = .511, p = .008
Normal Group:	CA:	r = .876, p = .0001
	Autism:	r = -.478, p = .024
	Normal:	r = .489, p = .021

Categories of Behaviors Generated By Factors Analysis

1. Interaction with People
2. Interaction with Objects
3. Solitary Behaviors
4. Response to Stimuli

As would be expected, Table 5 reveals that MA and CA are highly correlated for all groups. However, within the autistic group, the only other significant correlation found was a negative one between MA and the factor labled MR indicating that autistic children with higher mental ages are less likely to exhibit these behaviors. The fact that within the autistic group the other factors do not vary systematically with either CA or MA may partically account for the poor discrimination obtained in our earlier study. Furthermore, this finding might also reflect the heterogeneity of behaviors shown by children diagnosed as autistic.

Conversely, in the mentally retarded and normal groups, the factors which define groups of behaviors relating to people and objects do vary developmentally. For example, in the ratarded group, MA is negatively correlated with the MR factor and positively correlated with the normal factors. Thus, the higher the mental age of a retarded child, the more likely he is to exhibit behaviors labeled normal in this analysis.

Within the normal group, developmental trends are even more evident. For example, CA is negatively correlated with the factors labeled autism and people indicating that these factors may reflect behaviors exhibited by younger normal children. Furthermore, within the normal group MA is also negatively correlated with the autism factor while both MA and CA are positively correlated with the factor labeled normal.

DISCUSSION

The principal conclusion that can be drawn from these preliminary data is that developmental perspectives must be applied to the complex problem of diagnosing autism. These data clearly support our earlier findings that in order to develop objective behavioral diagnostic criteria, it is necessary to establish age specific norms for the frequencies of behaviors exhibited by autistic children (Freeman, Ritvo, Guthrie, Schroth and Ball, 1978; Freeman,

Guthrie, Ritvo, Schroth, Glass and Frankel, 1978). Also, behaviors of autistic children must be compared to those of chronological and mental age-matched groups of both normal and mentally retarded children. This is essential in order to distinguish behaviors exhibited by autistic children which are unique to the syndrome and therefore, of diagnostic importance from behaviors which result from maturation or from general delays in cognitive development. These data indicate that the importance assigned to any one behavior, or symptom can and does vary with the mental and chronological age of the child studied.

These data also expand our earlier results and indicate that not only individual behaviors but groups of behaviors can be statistically defined which describe diagnostic groups. Furthermore, these groups of behaviors can and do vary along developmental parameters. Therefore, before definitive diagnostic importance can be attributed to any group or sub-group of behaviors, they must be objectively studied in the same manner as individually coded behaviors. That is, all groups of behaviors must be analyzed as a function of both mental and chronological age as well a compared among groups of autistic, mentally retarded and normal children.

In addition to generating diagnostic data, the techniques described in this paper will be extremely important in identifying subgroups of children within a diagnostic category and/or a specific age range. These types of data are needed in order to begin to describe and define objectively the heterogeneous set of symptoms which are currently used to diagnose the syndrome of autism. Furthermore, objective identification of subgroups of children within a diagnostic group and within different age ranges will permit more accurate descriptions of subjects in research studies and subsequent correlation of biological variables with age and symptoms.

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Footnotes

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